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AUG 7 1984

CH2M HILL/WDC

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Cherokee County/Remedial Investigation and Feasibility Study

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G. PERIOD OF PERFORMANCE:

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SUPERFUND RECORDS

## Cherokee County Remedial Investigation/Feasibility Study

The Cherokee County Site encompasses an area of Cherokee County, Kansas from Crestline to just west of Treece on the Kansas-Oklahoma border and from the Tar Creek Drainage Basin east to the Kansas-Missouri border. This area is part of the lead and zinc mining region called the Tri-State Mining District, which includes portions of Cherokee County, Kansas, Ottawa County, Oklahoma, and Jasper County, Missouri.

The area is essentially honeycombed with mines. Water was continually pumped out of these mines during production. When mining activities ceased, and the pumping also ceased, the mines began filling with water through natural groundwater recharge and direct inflow of surface runoff via mine shafts, test holes, and subsidence areas.

### Nature and Extent of Problem

The mining activities resulted in a significant generation of milling wastes or tailings which are stored in giant piles throughout the area. In the presence of water, oxidation of iron sulfides which are present in the tailings can produce an acid which will result in the solubilization of heavy metals. Runoff and/or seepage from the tailings may contain high concentrations of heavy metals which can degrade the water quality of receiving streams.

The water which filled the abandoned mines reacted with the oxidized sulfide products in the mines to form mineralized acid mine water. The acid mine water and tailing piles runoff have resulted in the deteriorated quality of the groundwaters and surface waters in the area.

Studies indicate that there is a higher incidence of lung cancer in the Tri-State Area. It is suspected that this could be due to air quality deterioration caused by the mine tailings.

### History of Response Actions

The United States Geological Survey (USGS) conducted a study of the water in the mine shafts. This study, published in 1978, predicted that due to rising groundwater levels the mine water would eventually discharge to the surface. In December 1979, heavily contaminated groundwater began discharging at two locations in Ottawa County, Oklahoma. Following that, the State of Oklahoma and Region VI of the Environmental Protection Agency (EPA) began numerous studies on the hydrogeologic characteristics, groundwater quality, and surface water quality in the Picher Field (a portion of the Tri-State Mining District mainly in Oklahoma), including a Remedial Investigation and Feasibility Study of the mining area in Ottawa County, Oklahoma.

In May 1981, an epidemiological study reported a rate of lung cancer deaths in Cherokee County, Kansas higher than the national average. That report was followed up in 1983 with a study to verify the cancer incidences. Limited air quality studies have been conducted in the past.

In 1983, the Kansas Department of Health and Environment (KDHE) began a short term environmental study which included air quality monitoring to determine if there is a current potential health hazard caused by the tailing piles. This study is expected to be completed in the near future.

The USGS is completing an extensive study to determine the effects of the mines in the Tri-State Mining District on the surface water and groundwater quality. The published report is expected in the near future.

#### Objectives of the Remedial Investigation

The remedial investigations for the Cherokee County Site should include a more extensive review of existing literature and, if necessary, additional field activities, to determine the nature and extent of the Cherokee County Site contamination. If necessary, additional field studies should be conducted to collect data necessary for the development and evaluation of viable remedial action alternatives during a subsequent feasibility study. The objectives should include, but not be limited to, studies of: air quality, groundwater, surface water and stream sediments, ecology, mining, and agriculture. The studies should accomplish the following:

1. Investigate the extent of groundwater contamination for both shallow and deep sources of groundwater.
2. Investigate the extent and sources of surface water and stream sediment contamination resulting from mining activities.
3. Study the ecology of the area for indications of impacts resulting from environmental contamination.
4. Research historical site area mining activities and determine the location and current status of mines.
5. Investigate area agricultural practices to determine sources of water supplies for livestock and irrigation.
6. Investigate the extent and sources of air quality contamination resulting from mining activities.
7. Develop a potential list of viable remedial action alternatives from the data collected during the investigation and for further development in subsequent feasibility studies.

#### Objectives of the Feasibility Study

The feasibility study will be conducted primarily to develop and evaluate remedial action alternatives and will be an integral part of the remedial planning process.

The objectives of the feasibility study, based on the results of the remedial investigation, include:

1. Develop remedial action alternatives to control or eliminate the sources of contamination at the Cherokee County Site and prevent or decrease the rate of contaminant migration to offsite areas.
2. Evaluate remedial action alternatives considering costs, environmental effects, and engineering feasibility (cost-effectiveness).
3. Recommend a cost-effective remedial action alternative. The apparent lowest cost alternative, of those alternatives evaluated, that is technologically feasible and reliable and that adequately protects (or mitigates damage to) public health and the environment should be considered the cost-effective alternative.
4. Prepare a conceptual design of the recommended remedial action alternative.

### Remedial Investigation - Scope of Work

The currently available data and information pertaining to the Cherokee County Site is insufficient for complete development and evaluation of remedial action alternatives, and for conceptual design activities following selection of a preferred alternative. The following activities should be performed during the remedial investigation to meet the objectives:

Activity 1	Data Gathering for Investigation Support
Activity 2	Investigation Support
Activity 3	Preliminary Remedial Technology
Activity 4	Site Investigation, Phase I
	Site Investigation, Phase II
Activity 5	Site Investigation Data Analysis
Activity 6	Remedial Investigation Report
Activity 7	Management Activities
Activity 8	Community Relations Support

Numerous information and data exist on the Tri-State Mining District, including Cherokee County, Kansas, that was not readily available within the scope, timing, and budget of the Remedial Action Master Plan (RAMP) development process. In addition, several studies are now being conducted to gather site-specific air quality data, hydrogeological data, surface water quality data, and other pertinent information. All available existing data and preliminary information from ongoing studies should be gathered and reviewed prior to final development of the remedial investigation work plan and should be included into the data base for site characterization and future feasibility studies.

Much information is presently being gathered by the USGS on surface water and groundwater quality. Also, the RI/FS which has been prepared for Ottawa County, Oklahoma may include remedial investigations and evaluations of feasible remedial actions that are applicable to the Cherokee County Site. These sources of data should be used and not duplicated in this investigation.

Other known sources of existing information include the following:

- ° Kansas Department of Health and Environment: Cherokee County Air Quality-Soil Investigation
- ° Kansas Geological Survey: Existing Well Data
- ° Oklahoma Tar Creek Task Force
- ° U.S. Geological Survey: Cherokee County Hydrogeologic and Hydrologic Investigation, Jasper County investigations
- ° Bureau of Mines: Mine Surveys and Mine Stability
- ° Southwestern University, Joplin, Missouri: Depository of much of the hydrogeologic data for the Tri-State Mining District
- ° Missouri Geological Survey
- ° Oklahoma Geological Survey
- ° State (Kansas, Missouri, and Oklahoma) Water Quality Departments

## Activity 1 -- Data Gathering for Investigation Support

Activity 1 will include tasks required to obtain the background information needed to develop a comprehensive workplan. These tasks will include a kickoff meeting, development of a workplan for gathering additional information, existing data collection and evaluation, development of site safety plan, and a subcontractor procurement plan for the data collection evaluation.

Task 1-1. Kickoff Meeting - Upon receipt of the work assignment for this Remedial Investigation and Feasibility Study (RI/FS), a project team will be assembled. A meeting will then be held with the Remedial Site Project Officer (RSP0), other EPA personnel, and appropriate members of the RI/FS project team. The purpose of this meeting will be to introduce team members, define overall project approach and objectives, obtain relevant data, discuss sensitive issues, and establish channels of communication and reporting.

Task 1-2. Data Collection and Evaluation Workplan - A draft workplan will be prepared and submitted to the RSP0 for review and approval. This workplan will be for the project of gathering and evaluating the existing information on the site from the numerous sources. The workplan will include a budget and time schedule for this data gathering and evaluation project.

Task 1-3. Health and Safety Plan - A site health and safety plan will be developed for the remedial investigation activities. The plan will include a health and safety assessment to determine hazardous chemical exposure levels in the surface water, groundwater, air and soils within the site. Such information will be useful during the implementation of remedial investigations. The assessment will also provide local residents and field investigation teams with adequate warnings and safeguards.

The health and safety assessment should include, at least, the following generalized items:

1. An assessment of risks in terms of the environmental fate of the chemicals known to be onsite, potential human exposure (ingestion, dermal contact), and the type of toxicological affects (acute, subacute, or chronic).
2. Delineate restrictions that may apply to work at and in the vicinity of the site.
3. Develop safe work procedures.

The plan will be consistent with the following:

- ° Section 111(c)(6) of CERCLA
- ° EPA Order 1440.1 -- Respiratory Protection
- ° EPA Order 1440.3 -- Health and Safety Requirements for Employees Engaged in Field Activities

- EPA Occupational Health and Safety Manual
- Other EPA guidance as provided
- State safety and health statutes
- Site conditions

Task 1-4. Subcontractor Procurement Plan - A subcontractor procurement plan will be prepared to identify areas of the data gathering and evaluation project that are best suited for the use of subcontractors. In addition, this subtask will include the following activities for this portion of the project:

- Prepare draft subcontractor work plans;
- Identify potential subcontractors;
- Conduct subcontractor interviews;
- Prepare agreements; and
- Select the subcontractors.

Task 1-5. Data Collection and Evaluation - Following approval of the workplan, all existing information on the site will be collected and evaluated. The purpose of gathering the existing information is so that we do not repeat existing studies. Much information is presently being gathered by the USGS in Lawrence, Kansas on surface water and groundwater quality in Cherokee County. The RI/FS for Oklahoma's Tar Creek site includes valuable information that can be extrapolated to Cherokee County. The Kansas Department of Health & Environment has begun an air monitoring study in Cherokee County.

Other known sources of existing information includes the following:

- Kansas Geological Survey: Existing Well Data;
- Oklahoma Tar Creek Task Force;
- U.S. Bureau of Mines: Mine Surveys and Mine Stability;
- Southwestern University, Joplin, Missouri: Depository of much of the Hydrological Data for the Tri-State Mining District;
- U.S. Geological Survey (Rolla, Missouri) - Jasper County Missouri Water Studies.

Task 1-6. Interim Investigation Report - Activity 1 tasks should be summarized in an interim report to serve as a working document for subsequent activities. Six copies of this draft report will be supplied to the RSPO.

## Activity 2 -- Investigation Support

Activity 2 will include a series of tasks required to establish a definite site investigation program and comprehensive workplan. This series of tasks should include identification of goals, a site visit, and preparation of the QA/QC and workplans. In addition, the site boundaries and site map should be refined as a part of this activity.

Task 2-1. Identify Preliminary Goals and Objectives - The project team will identify preliminary cleanup goals and associated alternative remedial actions to assist in targeting the scope of investigations to be described in the work plan. These goals and options will be based on discussions with EPA and Kansas Department of Health and Environment (KDHE) personnel. They should include observations from site visits, conclusions drawn from the readily available background data, experience from the readily available background data, and experience from other sites. The preliminary goals and alternative remedial actions will be reviewed with EPA and KDHE personnel.

Task 2-2. Site Investigation Work Plan - Based on the to-date knowledge of feasible remedial action alternatives, a draft work plan will be prepared and submitted to the RSPD for review and approval. The work plan will incorporate the safety and QA/QC plans for the site, and the proposed field activities required for the site investigations identified in Activity 3. The need for property access agreements will be identified and obtained by the contractor.

In addition, the work plan will identify where subcontractors and specific equipment items are required during the remedial investigations. It also will include the procurement approach for subcontractors and equipment. Sampling plans and field protocols will be addressed in the work plan or appropriate portions of the quality assurance plan.

The work plan will include a statement of the objectives of the remedial investigation and outline potential remedial action technologies for the site, including specific data requirements needed to evaluate those technologies. Six copies of the final work plan will be submitted to the RSPD after receipt of written comments from EPA on the draft plan. However, the workplan should be a flexible document and be revised as the data base is enlarged and as new information may change the direction of the investigation. Revised work plans will be submitted to the RSPD for review and approval before initiating the work.

Task 2.3. Quality Assurance/Quality Control Project Plan - A site specific quality assurance/quality control (QA/QC) project plan will be developed. The plan should include any needs specific to the work assignment or requested by EPA as a result of extraordinary project requirements.

The plan will be consistent with requirement of EPA's Contract Laboratory Program. It will also address the following:

1. QA Objectives for Measurement Data, in terms of precision, accuracy, completeness, representativeness, and comparability.
2. Sampling Procedures.
3. Sample Custody.



4. Calibration Procedures, References, and Frequency.
5. Internal QC Checks and Frequency.
6. QA Performance Audits, System Audits, and Frequency.
7. QA Reports to Management.
8. Preventive Maintenance Procedures and Schedules.
9. Specific Procedures to be used to routinely assess data precision, representativeness, comparability, accuracy, and completeness of specific measurement parameters involved. This section will be required for all QA project plans.
10. Corrective Action.

Task 2-4. Subcontractor Procurement Plan - During review and preparation of the investigation support, a subcontractor procurement plan will be prepared to identify areas of the investigation that are best suited for the use of subcontractors. In addition, this subtask will include the following activities: prepare draft subcontractor work plans, identify potential subcontractors, conduct subcontractor interviews, prepare agreements, and select the subcontractors.

Task 2-5. Site Map - A site map will be prepared showing topographic features, tributary streams, tailings areas, building and utilities, sewage and industrial outfalls, and other pertinent project features. The site map or maps will be sufficient for identifying current and planned onsite studies and sampling locations. There are existing aerial photos to provide the information to develop this map.

Task 2-6. Define Boundary Conditions - Site boundary conditions will be established to limit the area of site investigations. The boundary conditions will be set so that subsequent investigations will cover the contaminated media in sufficient detail to support following activities (e.g., the feasibility study). The boundary conditions may also be used to identify boundaries for site access control and site security.

Task 2-7. Aerial Photo Interpretation - In order to provide information for subsequent tasks, aerial photos of the site will be interpreted for features indicating mining activity and its impacts. Mining activities of particular interest include evidence of seeps, springs, subsidence and vegetation stress.

### Activity 3 -- Preliminary Remedial Technologies

This activity will be conducted prior to, during, and after the site investigations, Activity 4. Prior to site studies, project engineers and scientists will identify and review potential remedial actions that could be taken at the Cherokee County Site. This review will include any prior responses taken or attempted by agencies or mining companies. The object will be to identify the source control and offsite measures that are reasonable for the site, and ensure that site investigations provide the data necessary to develop and evaluate these alternatives.

During site investigations, the activity will be primarily for quality assurance. Project team members will review study results as they become available to ensure that all reasonable and practical alternatives are considered and to fine-tune data collection activities if required.

During or immediately following site investigations, project team members will recommend preliminary remedial technologies as the basic framework for developing the final set of remedial alternatives. This activity will support the fine-tuning of site investigations and provide a refinement of alternatives considered as feasible prior to Activity 4. The Preliminary Remedial Technologies should be presented in a table, or matrix, with all technologies or actions shown and one sentence qualifiers for the criteria. Criteria should include, but not be limited to, applicability to the problem, reliability, implementability, damage to the environs, initial cost, operation and maintenance, etc. This should be a separate deliverable for use in negotiations and planning.

#### Activity 4 -- Site Investigation

Site Investigations will assist in characterizing the site and defining actual or potential public health and environmental hazards. In addition, these studies are needed to adequately develop and evaluate remedial alternatives. Site investigations at the Cherokee County Site should be conducted in two time periods or phases, referred to hereafter as the Phase I Investigations and Phase II Investigations. The phased approach allows tailoring of the scope of the site investigation in a manner appropriate to the hazards determined at the site and to the appropriate remedial measures for those hazards.

Phase I Investigations should be conducted to determine the nature and general extent of the problems at the site and whether/how they pose significant public health or environmental hazards. This information will be needed to determine the scope of further Phase II Investigations commensurate to the hazards identified and the site conditions. In addition, Phase I Investigations should be compared to previous studies to denote similarities or changes in the current site conditions.

Investigations presently ongoing with the USGS and the Oklahoma Water Resources Board should not be duplicated in this investigation. Those studies will have to be reviewed before preparation the final Phase I and II investigation work plan. The activities laid out in this scope of work are only to provide a general explanation of data needed.

It is possible that at the completion of Phase I Investigations, further Phase II Investigations may not be deemed necessary. In this case, effort may be shifted directly to Feasibility Studies or Remedial Actions as appropriate.

Phase II Investigations represent those field studies that provide more detail on the site and expand the data base needed for developing and evaluating remedial action alternatives. Phase II studies should be considered as the more intensive and extensive phase of the remedial investigations at the site that will follow Phase I, if Phase I

Investigations determine that conditions at the Cherokee County Site are significantly impacting the environment or endangering the public health, or if the Phase I Investigations are insufficient to evaluate remedial action alternatives.

### Phase I Investigations

The primary objective of Phase I Investigations is to determine how the Cherokee County Site is currently impacting the environment or posing a significant health hazard. If Phase I studies determine there is not significant impact or hazard, then Phase II Investigations can be bypassed or revised and the remedial investigation can be reduced to address specific problems. If Phase I studies reveal significant impact, the Phase II remedial investigations should be initiated unless it is determined that Phase I Investigations provide sufficient data to proceed directly into Feasibility Studies for appropriate site remedial actions.

If the data is not already available from other sources, Phase I Investigations will consist of a set of tasks to provide site characterizations of hydrogeology, surface water quality, ecology, mining, agricultural water uses, and air quality, and also provide an assessment of the environmental and health hazards posed by the mining contaminants. Phase I Investigations will include thorough reviews of available data, limited field investigations, and limited sampling and testing. Potential Phase I tasks are described below.

#### Task PI-1. Hydrogeologic Investigation

A Phase I hydrogeologic study should be conducted to determine the water quality of existing wells that penetrate the Roubidoux, Jefferson City-Cotter Dolomite, and Boone aquifers within Cherokee County, and to attempt to identify the vertical and lateral extent of the migration of contaminated groundwater. All available data will be used in lieu of developing new data, therefore some of the below subtasks may be eliminated as the existing data is located.

##### Subtask PI-1-1. Existing Well Inventory

An inventory of existing domestic, stock, irrigation and exploratory mine wells within the site is needed to determine well ownership, location, use, pumping rate, well drilling, and borehole geophysical log information, well test data, and to determine which, if any, wells can be used for sampling, aquifer testing, or logging. Wells within the Boone, Jefferson City-Cotter Dolomite, and Roubidoux aquifers should be inventoried. Much of the information can be obtained from recorded well permits or well logs with telephone confirmation with well owners and from published groundwater, mining, or geology reports. However, some field confirmation will probably be required.

Sampling and geophysical logging of existing wells should be determined from the well inventory results. The general bases for initiating this work should include information concerning well use, the aquifers penetrated, lithologic data, well construction, water quality indications, and proximity to abandoned mine areas and flow boundaries.

#### Subtask PI-1-2. Groundwater Sampling and Analysis

Groundwater from selected active and abandoned wells should be sampled to determine water quality. Groundwater sampling may be needed on all domestic wells in the area. After the initial sampling of the selected wells, the data should be evaluated to determine if additional sampling is required to confirm water quality. If poor laboratory analysis is evident, additional sampling may be required. The exact number and location of wells, as well as aquifer interval, to be sampled should be determined in Subtask PI-1-1.

Each sample recovered should be analyzed for the inorganic contaminants listed in Table 1. Other contaminant analyses may be needed as the monitoring program develops; however, the initial task plan assumes that the analysis will include only these inorganic contaminants. Also, if it is found that the whole list of contaminants need not be analyzed, the list should be revised. Sample extraction should be made according to standard EPA procedures. Chain-of-custody procedures will be strictly followed.

#### Subtask PI-1-3. Groundwater Flow and Aquifer Testing Investigation

Static water levels should be measured in selected active or abandoned wells if these wells are found to be appropriate for such measurements. Groundwater levels in these wells that penetrate key aquifers in the site area may be used to determine groundwater flow patterns in Cherokee County.

Aquifer testing should be conducted in existing wells, where possible, if site-specific aquifer characteristics cannot be obtained in Subtask PI-1-1. A constant discharge test of sufficient duration would be completed in key aquifers to determine transmissivity and hydraulic conductivity values. These values would be used in conjunction with hydraulic head measurements to determine groundwater flow directions and the lateral extent of contamination.

#### Subtask PI-1-4. Borehole Geophysical Investigation

A borehole geophysical investigation of existing wells should be conducted using selected functions where well construction details, lithologic logs, or aquifer depths and characteristics are so vague that essential information cannot be obtained. Eight geophysical functions are available to assist in the characterization of the confined aquifer system. These include the spontaneous potential, resistivity, fluid temperature, caliper natural gamma, neutron-neutron, gamma-gamma, and sonic functions. Subtask PI-1-1 results will determine if and in what well, and to what depth interval, this task will be performed.

#### Subtask PI-1-5. Data Evaluation

The data collected in Subtasks PI-1-1 through PI-1-4 should be thoroughly evaluated to determine areas of groundwater contamination that may adversely impact the public health or environment. Existing wells should be evaluated for their use during Phase II Investigations. A tabulation of all the information is required, including a cursory map presenting the hydrogeologic gradients and potentiometric surface of key aquifers, and flow boundaries within the site area.

Table 1  
Analytical Parameters

Inorganics

Alkalinity	Magnesium
Aluminum	Manganese
Ammonia	Mercury
Antimony	Molybdenum
Arsenic	Nickel
Barium	pH (field measurement)
Beryllium	Potassium
Boron	
Cadmium	Selenium
Calcium	Silver
Chlorides	Sodium
Chromium	Specific conductivity (field measurement)
Cobalt	Sulfate
Copper	Sulfide
Cyanide	
Hardness	Temperature (field measurement)
	Thallium
	Tin
Iron	Total Dissolved Solids
Lead	Vanadium
	Zinc

Notes:

1. All sampling and testing should conform to guidelines in the User's Guide to the U.S. EPA Contract Laboratory Program (CLP) prepared by the Sample Management Office CLP and published in August 1982.
2. All waste samples should be considered low concentrations samples according to the CLP criteria.
3. All sediment, tailing, and soil samples should initially be considered medium concentration sampling according to the CLP criteria.

A task memorandum will be prepared to present the results and conclusions of this task and suggest a Phase II scope of work, if required.

#### Task PI-2. Surface Water Quality Investigation

Comprehensive water quality data for the site area may not be available. Therefore, a water quality investigation should be performed if sufficient information is not located. The purpose of this investigation will be to determine the quality of surface waters at the site area boundaries, and to determine if, how and approximately where the primary surface waters in the site area are being impacted by mining contaminants.

##### Subtask PI-2-1. Identify Appropriate Monitoring Locations

Before specifying precise locations for monitoring points, available surface water quantity records from sources such as the State Engineer's office and USGS will be reviewed to determine the relative sizes of the surface water bodies within the Cherokee County Site area. Water quality records from sources such as the State Health Department, USGS and STORET will also be reviewed to determine what water quality data has previously been gathered and at what locations. Review of aerial photographs for mine seeps and springs, as discussed in Task PI-4, may reveal potential sources of contamination that will be useful in selecting monitoring locations. After reviewing the information above, the site area will be inspected and specific monitoring locations be designated, if necessary.

##### Subtask PI-2-2. Sample Surface Waters

The largest surface water system within the site area consists of the Spring River and its tributaries. The upper reaches of the Tar Creek drainage are also located within the site area. It is proposed that these streams be monitored at several locations if reliable data cannot be located. In addition, points just upstream and downstream of potential major sources of contaminants, should be monitored. Potential major sources that will be considered include mine tailing piles, mill ponds, mine water discharges, cities and industries.

Samples collected should be analyzed for the major analytical parameters shown previously in Table 1. Every attempt should be made to ensure that the sampling period covers seasons of both high precipitation and low precipitation.

##### Subtask PI-2-3. Sample Sediments

In order to determine if mining contaminants are precipitating and concentrating in areas where the precipitates settle, river and creek bottom sediments should be sampled in conjunction with the surface water sampling program. Rivers and creek sediments within the site area should be sampled at locations where sedimentation of contaminants is likely to occur. Sedimentation typically occurs in stream reaches where the velocity decreases abruptly, such as locations where the cross-sectional area of

the stream increases. Areas where chemical changes in the water occur may cause precipitation of a soluble contaminant which then settles to the bottom of the stream. This can occur below confluences of waters having differing water chemistry, or downstream of industrial or municipal discharges.

#### Subtask PI-2-4. Sample Tailings Runoff

In order to determine the potential impacts that tailings runoff could have upon surface waters, tailings runoff should be sampled and analyzed for the same parameters as surface waters and sediments.

#### Task PI-3. Ecology Investigation

If not previously done by the U.S. Fish and Wildlife Service or another organization, ecological studies will be conducted to characterize the aquatic and terrestrial ecosystems in the Cherokee County Site, and investigate actual or potential impact to the biota in areas where mine water discharges and mine tailings runoff occurs. The Phase I studies should be semi-quantitative in nature, and designed to provide baseline information over a wide area. Five subtasks are proposed:

1. Literature search and agency interviews
2. Aerial photo reconnaissance
3. Aquatic ecology survey
4. Terrestrial ecology survey
5. Agricultural studies

#### Subtask PI-3-1. Literature Search and Agency Interviews

Substantial information exists on the general ecology of the Kansas Prairie, the Ozark Plateaus, and the Tri-State Mining District; and site-specific data has been collected during studies addressing developments along the Spring River and mining impacts in the Tri-State area, especially northeastern Oklahoma. The Phase I ecology studies will take full advantage of the existing data because of the large area that must be covered and the fact that Phase I objectives can be met to a large extent with general area-wide information.

The existing ecological information will be collected through a literature search and by meeting and writing State and Federal agencies. Kansas State agencies that should be contacted include:

- ° Fish and Game Commission
- ° State Extension Services
- ° Geological Survey

- ° Mined Land Conservation and Reclamation Board
- ° State Department of Health and Environment
- ° State Biological Survey
- ° Kansas Ornithological Society

Several Oklahoma agencies also should be contacted, especially the Tar Creek Task Force--Environmental Effects Subcommittee. Federal agency contacts should include the Soil Conservation Service, U.S. Fish and Wildlife Service, U.S. Geological Survey, the U.S. Army Corps of Engineers, Department of Agriculture, and U.S. Bureau of Mines.

#### Subtask PI-3-2. Aerial Photo Reconnaissance

Interpretation of aerial photographs is one of the more efficient methods for inventorying and characterizing the terrestrial vegetation and land uses over a countrywide area. This type of study has already been done to some extent in Cherokee County and in northeastern Oklahoma. The Tar Creek Task Force and EPA will be contacted to acquire the existing aerial photo interpretations applicable to the Cherokee County Site to preclude duplicating these earlier studies.

Existing aerial photographs should be obtained and studied by interpreters experienced in identifying physical and vegetation features. The major objectives of the photo reconnaissance study will be to:

1. Identify and delineate the major vegetation habitat types, crops and pastureland, disturbed mine lands, and other major land uses.
2. Prepare maps of major habitat types and land uses.
3. Locate major mine tailing deposits, milling ponds, subsidence areas, and mine water discharges. This information should be used to assess the land area impacted by abandoned mines and assist in locating terrestrial and aquatic sampling sites.
4. Identify and delineate vegetation stressed by current mine-related surface or subsurface contaminants, or other factors.
5. Supplement field studies to assess the potential wildlife value of major habitat types in Cherokee County.
6. Identify areas where sediments from chat piles and tailings piles have encroached on streams and agricultural areas.

To supplement the photo reconnaissance, state, regional, and Federal agencies should be contacted for existing land use data and land use plans.



### Subtask PI-3-3. Aquatic Ecology Survey

If not already done, sampling stations should be established to characterize the aquatic biota in Spring River and major tributaries within Cherokee County and compare the aquatic ecology of the upper reaches of Tar Creek in Kansas with the known impacted stretch in Oklahoma.

Aquatic ecology samples could be taken in the spring and again in mid or later summer to determine the density and diversity of fish and benthic macroinvertebrates and qualitatively assess the relative abundance of aquatic plants and periphyton. The physical and chemical characteristics of each sampling area should also be described, utilizing appropriate data from water quality and sediment sampling tasks that should be done concurrently.

### Subtask PI-3-4. Terrestrial Ecology

General surveys should be conducted at selected locations within the Cherokee County study site to determine the type and relative abundance of plants and animals in the area, characterize the natural and introduced vegetation, and document impacted areas (i.e., stressed vegetation, disturbed areas, etc.). The general survey work should be supplemented by (and preceded by) meetings with agencies, a literature review, and aerial photo reconnaissance.

Major habitat types within the study area should be delineated on site maps and areas representative of each major habitat type should be selected for sampling surveys. Sampling surveys should include qualitative reconnaissance of each selected area (two or more areas for each habitat type) by experienced field biologists to characterize the vegetation, game and nongame animals, and birds of each habitat type. Surveys could be conducted during the spring and again in mid to late summer, and areas selected for sampling should include both impacted and undisturbed lands.

Standard methods will be used to analyze and combine the data from all informational sources (i.e., field surveys, aerial photos, and agency interviews), and characterize the existing terrestrial ecology. Items to be considered during this study should include:

1. Location and aerial extent of stressed vegetation.
2. Wildlife value of major habitat types.
3. Current and potential future land use.
4. Location and aerial extent of significant land disturbances by prior mining activities.
5. Distribution and relative abundance of the area's natural resources (for example; big game animals, good pastureland, etc.).
6. Potential for reclamation.

#### Subtask PI-3-5. Agricultural Investigations

Studies should be conducted within the Cherokee County Site to assess the impact of prior lead-zinc mining activities on the existing and potential agricultural usage of the area. Using information from Subtasks 1 and 2, the location and extent of existing agricultural land should be displayed on site maps. Existing information should then be used to select areas in the county to study the potential or actual impact of surface water and groundwater quality on agricultural operations, test soils in areas of known mining operations to see if they are suitable for agricultural use, and evaluate the potential for reclamation of disturbed lands.

Information collected during Subtasks 1 and 2 of the Ecological Investigations, and during the Groundwater and Surface Water Investigations should be used to locate places where irrigation diversion water and water from irrigational and stock wells has been contaminated. Areas considered to be potentially the worst should be selected and water quality samples should be taken at these locations. Samples should be analyzed for heavy metals and other inorganic parameters (Table 1). Sampling locations should be limited. The major objective for this activity is to determine if contamination exists at some locations within the county, and if so, how significant the contamination might be with respect to raising crops and livestock. These subtasks should not be designed to inventory and sample all potential areas of contamination in the Cherokee County area. If Phase I documents that a significant problem exists at some locations, then Phase II studies should be conducted to inventory the county.

A similar approach should be used to test soil samples from a few selected areas that have a high probability of being contaminated with heavy metals. Again, Phase I studies should be conducted to determine if a significant problem exists; then Phase II studies would measure the extent of the problem.

As part of the Phase I agricultural investigations, a thorough literature review will be conducted to evaluate the potential for reclamation of tailing pile areas and lands disturbed by prior mining activities. The critical issues that will be studied include the phytotoxicity of zinc and other heavy metals in tailings piles and impacted soils, and the lack of organic constituents in the tailings and other mine wastes.

#### Task PI-4. Mining Investigation

Site area mines will be investigated since they are the source of the mining contaminants. In order to determine the locations, extent, and current status of mines within the Cherokee County Site area, the Kansas State Bureau of Mines, Kansas Geological Survey, and U.S. Bureau of Mines will be contacted as sources of information. Such agencies will also be asked to provide information regarding the geology of the mining areas, including the types of materials removed from the mines and characteristics of the host material; as well as information relating to the local geohydrology, including groundwater studies and management programs.

It will be determined whether or not records of the mining area have been kept by the Kansas Mineral Land Conservation and Reclamation Board under the abandoned mine lands program. This agency may have information regarding the current status of individual mines including whether the mines are open or sealed and whether or not subsidence, springs or seeps have occurred. A review of existing aerial photographs may aid in identifying areas of mining activity and surficial impacts.

#### Task PI-5. Air Quality Investigation

Currently, an air sampling program is being conducted by the Kansas Department of Health and Environment in Cherokee County, Kansas. The study will collect 24-hour high-volume particulate filter samples on a 6-day schedule for about 90 days. The particulate samples will be analyzed for various heavy metals and gross alpha and beta radiation.

In addition, meteorological data will be collected during the State's investigation.

This task of the remedial investigation will require working closely with the Kansas Department of Health and Environment to gather and assess the data obtained from this recent investigation.

This task will also include an inventory of the tailings piles to determine current wind erosion patterns and to identify any areas exhibiting an impact on the air quality of the area that might require additional particulate sampling and analysis.

#### Task PI-6. Data Analysis/Phase I Report

At the completion of Phase I activities, an interim report should be prepared presenting the results of all Phase I Tasks. Six copies of the Phase I report will be submitted to the RSPD. The major objectives of the Phase I Report will be to:

- ° Characterize the physical and biological features of the site.
- ° Document the type of contaminants at the site, the onsite distribution of these contaminants, and the suspected movement of contaminants in the air, surface water and groundwater systems.
- ° Compare the collected data with previous study results to identify any changes and to determine if past studies are directly applicable to the Feasibility Studies.
- ° Review the suggested remedial action alternatives developed prior to the site investigations and revise or develop new alternatives based on the Phase I results.
- ° Provide baseline data for designing Phase II studies, if required.
- ° Present a scope of work for Phase II remedial investigation (if required), including schedule and cost estimates, for EPA review and approval.

## Phase II Activities

Phase II activities will be designed to provide more comprehensive data on surface water quality and hydrology, groundwater hydrology and water quality, and aquatic ecosystem, if required. These Phase II activities will provide data needed to develop realistic remedial action alternatives and evaluate these alternatives. In most cases, the same chemical and physical analyses should be measured in Phase II as in Phase I. The principal difference between the two programs is the possible addition of groundwater monitoring wells and the potential extension of monitoring programs to include additional sampling locations, streamflow measurements and/or a greater duration of monitoring periods.

Task memorandums will be used to present the data and conclusions of each Phase II task and address the filling of data gaps and the data base required for evaluation of remedial alternatives.

### Task PII-1. Hydrogeologic Investigation

Phase II hydrogeologic studies, if required, would include the installation of several deep wells to enable the groundwater sampling and pump testing of key confined aquifers. Borehole geophysical logging of these wells would also be conducted to delineate hydrostratigraphic units at depth. These wells would be used to further delineate the level and extent of groundwater contamination and to further define the characteristics of the confined aquifers.

#### Subtask PII-1-1. Deep Monitoring Well Installation

Phase II should include the installation of several large-diameter wells which penetrate the dolomitic aquifers. These wells would provide lithologic logs of the subsurface and access to confined aquifers. Wells should be drilled to provide water level, water quality, and borehole log data from confined aquifers within the dolomites.

The deep wells should be drilled using large-diameter casing and conventional water well drilling equipment (cable tool or air rotary). The Boone Formation should be securely sealed off from the underlying confined aquifers with cement grout due to the potential for groundwater contamination from this aquifer. During drilling, strata should be logged in the field.

Drilling and well design should be done per existing EPA, state and local regulations. Drilling equipment should be decontaminated between holes, and any materials used in well construction should be cleaned prior to installation.

After the completion of drilling, screen and casing should be installed. Screens may need to be gravel packed, capped with sand, and sealed by cement grout or other suitable seal. Wells should be developed by surging and pumping. All well elevations should be surveyed to a single project datum, and water elevations should be measured only after the wells have stabilized.

Any waste generated during the hydrogeologic investigation will be stored, treated, or disposed of in accordance with the site health and safety plan.

#### Subtask PII-1-2. Groundwater Sampling and Analysis

During and after installation of the confined aquifer wells, groundwater samples should be collected from each well. During drilling, samples may be collected incrementally below the Boone aquifer to determine the vertical variation in inorganic constituents with depth. Several inorganic constituents may be field-tested to pinpoint zones of aquifer contamination. Subsequently, these zones would be isolated with packers and representative groundwater samples would be collected. Alternatively, packer samples may be obtained directly from confined aquifer zones, therefore bypassing the in-field analysis step completely. The most efficient sampling procedure will be determined on the basis of Subtask PI-1-5 evaluations.

After drilling, development, and stabilization of the confined aquifer wells, one groundwater sample should be obtained from each well. Standard EPA sampling procedures, using acceptable pumping techniques, should be used.

Prior to taking the water sample, the static water level should be measured and recorded. Then, the well should be purged at least five well columns. Following the presample well purge, the pH, temperature, and specific conductance of the groundwater sample should be stabilized, measured, and recorded.

The groundwater samples from each well should be sent to an EPA approved commercial laboratory for chemical analyses. These analyses will provide initial data on groundwater contamination, and results should be used to design an effective monitoring program during Phase II. The water samples from each well should be tested for the inorganic elements listed in Table 1.

A second set of samples, to provide replicate data from each well, should be collected three or four weeks after the first set. Water levels and field data on pH, temperature, and specific conductance should also be taken with each sample.

#### Subtask PII-1-3. Aquifer Testing

During drilling of new wells, significant water-producing zones should be isolated using packers so that hydraulic head measurements can be taken and pump tests can be completed to determine transmissivity and hydraulic conductivity values. These aquifer characteristics aid in determining groundwater flow directions and the extent of contaminated groundwater migration.

Static water levels should be observed in an aquifer for a sufficient period of time to determine if the aquifer responds to changes in atmospheric pressure. If so, a calculational step is added to the pump test analysis to compensate for barometric influences. A constant discharge test of sufficient duration follows the barometric efficiency test so that flow characteristic of the aquifer can be determined.

#### Subtask PII-1-4. Borehole Geophysical Investigation

Each new well should be logged with a suite of borehole geophysical functions to sufficiently identify aquifer zone thicknesses and depths, lithologic character, bulk densities and porosities, and water quality and temperature characteristics. Eight geophysical functions are available to aid in obtaining this information. They include the spontaneous potential, resistivity, fluid temperature, caliper, natural gamma, neutron-neutron, gamma-gamma, and sonic functions. All, or a selected few of these logs, may need to be completed at aquifer zones or along the entire depth of the well. Phase I investigational results will clarify the focus of the borehole geophysical logging task.

#### Task PII-2. Surface Water Investigations

If the data gathered during the Phase I investigations indicates that specific stream reaches or tributaries have water or sediment containing relatively high levels of contaminants, it may be necessary to monitor water and/or sediment at additional locations in order to determine the precise source of the contaminants. It also may be necessary to monitor flows as well as analytical parameters at locations where significant contamination is found to exist to determine contaminant mass loadings.

#### Task PII-3. Ecological Investigations

Phase I ecological investigations were designed primarily to characterize the general ecology of the Cherokee County study area, and determine if significant impacts exist due to prior lead and zinc mining in the area. If impacts are documented during Phase I in the areas with high impact potential, then Phase II studies should follow. The objectives of Phase II ecological studies would be primarily to:

1. Determine the extent of the significant contamination.
2. Evaluate the severity of the problem.
3. Assess the potential for successful remedial action, including reclamation of some areas.

The scope of Phase II investigations is entirely dependent on Phase I study results. However, for purposes of planning, the following subtasks are presented as potential activities during Phase II.

#### Subtask PII-3-1. Aquatic and Terrestrial Biology Studies

If Phase I studies determine that some streams or valuable terrestrial habitats are impacted by mining activities, then Phase II studies should be conducted to determine how serious the impact is and assess the potential for mitigation. At this point in time, the following methodology is proposed. Several control (unimpacted) and test (impacted) stations should be selected and the biota at those stations should be sampled over a 3-to 6 month period. Parameters such as abundance, density, frequency

of occurrence, growth or productivity, etc., should be used to compare the control and test areas. If appropriate, simple trial remedial actions might be taken in the test areas to see how the biota might react; for example, liming the soil to alter the availability of heavy metals for plant use.

Phase II biology studies could also include an expansion of the Phase I survey programs to better define the extent of impact on the aquatic and terrestrial ecosystems within the Cherokee County Site.

#### Subtask PII-3-2. Bioassays

The toxicity of a heavy metal such as zinc is influenced by the site-specific nature of the medium. For example, zinc toxicity to fish varies depending upon the temperature, pH, hardness, and dissolved oxygen in the water. If Phase I studies indicate significant levels of heavy metals exist in some streams or soils, then bioassays should be conducted to determine actual impacts on representative plants or animals.

A bioassay study should also be conducted using native grasses to study the effect of zinc and lead phytotoxicity in representative soil types from Cherokee County and from mine waste areas. The objective in this study would be to determine where or under what conditions reclamation of wasteland would be precluded by phytotoxicity.

#### Subtask PII-3-3. Plant and Animal Tissue Analyses

If Phase I studies determined that streams of sport fishing value or agricultural land contains significant levels of heavy metals, then tissue analyses should be conducted during Phase II to determine the potential health impact of these heavy metals being passed through the food chain to man. Tissue analyses could involve sport fish, commercial crops, or livestock.

#### Task PII-4. Mining Investigation

If the sources researched during the Phase I mining investigation are not comprehensive enough to provide the information needed, additional sources should be investigated. Since large-scale mining activity in the Cherokee County site ceased in the mid-1960's, employees or former employees of the mining companies could be identified, located, and questioned.

#### Task PII-5. Air Quality Investigations

Phase II air quality investigations, if required would include particulate sampling and analysis at selected locations within the site identified as potential sources of airborne contamination and not sampled in the current air quality investigation by the State of Kansas.

High-volume particulate air sample locations would be established with air samples taken every 24 hours on a weekly schedule for several months. The analysis would include the heavy metals identified as potential contaminants in the Phase I investigation task.

### Activity 5 -- Site Investigation Data Analysis

Team members responsible for the tasks under Activity 4 - Site Investigation will prepare a thorough analysis and summary of all site investigations and their results. The objective of this task will be to ensure that the investigation data are sufficient in quality and quantity to support the feasibility study.

The results and data from all site investigations must be organized and presented logically so that the relationships between site investigations for each medium are apparent.

The analyses will include all significant pathways of contamination and an exposure assessment. The exposure assessment should describe any threats to public health, welfare, or the environment. Respective data sets should be analyzed and described with the following report objectives in mind:

- ° Identify the sources of air and water contamination, resulting from mining contamination, within the Cherokee County Site area.
- ° Determine extent of contamination.
- ° Assess the potential impacts and hazards of contamination on public health and the environment.
- ° Provide data for evaluation and selection of remedial action alternatives.
- ° Provide information for selecting source controls, offsite measures, or an appropriate combination.

The results of the site investigation will be analyzed in relation to the preliminary remedial technologies developed in Activity 3. Data supporting, or rejecting, types of remedial technologies, compatibility of wastes and construction materials, and other conclusions should be presented.

Activity 5 activities will include developing a report outline for the remedial investigation report.

### Activity 6 -- Remedial Investigation Report

All data collected during the remedial investigation will be summarized in a Remedial Investigation Report for submission to EPA. Prior to drafting the report, a few team members will meet with EPA to discuss the results of site studies and review the report outline. At this time, viable remedial actions will be discussed and the proper level of effort defined for the report. In addition, the team should address the level of effort in the feasibility study.



To determine the viability of the various alternatives, the following factors will be qualitatively evaluated as they relate to the project objectives:

- ° Ability to control onsite release or to mitigate offsite impacts (high, medium, or low).
- ° Adverse environmental impacts of each alternative (high, medium or low).
- ° Feasibility, applicability, and reliability of remedial action method for location and conditions of release (yes, no, potential).
- ° Preliminary cost estimate indicator (high, low, medium) for both capital and operation and maintenance costs.

The Remedial Investigations Report should include the results and conclusions of Activities 1 through 4, and incorporate basic data summaries in an appendix. The report will be structured to enable the reader to cross reference with ease.

Six copies of the draft Remedial Investigations Report will be submitted to the RSPD for review. After receipt of written comments from EPA and revision made the report will be finalized. Six copies of the final report will be submitted to the RSPD.

#### Activity 7 -- Management Activities

During the entire process of implementing the remedial actions at the Cherokee County Site, including initial planning, site investigations, and the feasibility study, several management activities are required. Technical and financial progress/status reports will be submitted monthly to EPA.

Technical progress reports for each work assignment will include progress-to-date and percent completion estimates. The report will compare actual completions with the prior months' plans and explain any deviations. Difficulties encountered and actions taken to rectify those problems will be presented. The progress reports will also include any known or proposed staff changes and planned activities for the next month.

The financial report will identify actual expenditures for the month and project-to-date cumulative costs including direct labor hours and fee dollars. The report should also include graphic comparisons of proposed versus actual expenditures, actual versus target direct labor hours, and projections of cost to completion. Any variations in actual or projected costs should be explained.

All field sampling activities will be documented on project-specific sample control forms and the required chain-of-custody procedures (with documentation) will be followed.

Critical project communications will be documented by telephone memos, notes of conference, letters, work order requests, etc., and kept in a project specific file.

Safety plans, QA/QC plans, and standard operating methods will be prepared and made available to appropriate project team members.

As stated previously, the safety plan will be consistent with:

- ° Section 111(c)(6) of CERCLA
- ° EPA Order 1440.1 -- Respiratory Protection
- ° EPA Order 1440.3 - Health and Safety Requirements for Employees Engaged in Field Activities
- ° EPA Occupational Health and Safety Manual
- ° Other EPA guidance as provided
- ° State safety and health statutes
- ° Site conditions

The Quality Assurance/Quality Control Plan will be prepared and submitted as part of the work plan for the sampling, analysis, and data handling aspects of the remedial investigation. The plan will be consistent with the requirements of EPA's Contract Laboratory Program. The plan will address the following points:

1. QA Objectives for Measurement Data, in terms of precision, accuracy, completeness, representativeness, and comparability.
2. Sampling Procedures.
3. Sample Custody.
4. Calibration Procedures, References, and Frequency.
5. Internal QC Checks and Frequency.
6. QA Performance Audits, System Audits, and Frequency.
7. QA Reports to Management.
8. Preventive Maintenance Procedures and Schedule.
9. Specific Procedures to be used to routinely assess data precision, representativeness, comparability, accuracy, and completeness of specific measurement parameters involved. This section will be required for all QA project plans.
10. Corrective Action.

### Activity 8 -- Community Relations Support

An additional requirement is to assist in furnishing the personnel, services, materials, and equipment required to undertake a community relations program. The objectives of this effort are to achieve community understanding of the actions taken and to obtain community input and support prior to selection of the remedial alternative(s).

Community relations support includes but may not be limited to the following:

- ° Revisions or additions to community relations plans including definition of community relations program needs.
- ° Analysis of community attitudes toward proposed actions.
- ° Preparation and dissemination of news releases, fact sheets, slide shows, exhibits, and other audio-visual materials, designed to apprise the community of current or proposed actions.
- ° Establishment of a community information center.
- ° Arrangement of briefings, press conference, workshops, and public and other informal meetings.
- ° Assessment of the successes and failures of the community relations program.
- ° Preparation of reports and participation in public meetings, project review meetings, and other meetings as necessary to the normal progress of the work.
- ° Solicitation, selection and approval of subcontractors, if needed.

All community relations support must be consistent with:

- ° Superfund community relations policy, as stated in the "Guidance for Implementing the Superfund Program."
- ° Community Relations in Superfund -- A Handbook.

### Feasibility Study - Scope of Work

The feasibility study will develop and evaluate reasonable alternatives and then recommend a cost-effective alternative to the EPA. Following review and approval, a conceptual design will be developed for the selected alternative and a final report prepared. The scope will consist of the following general activities:

- |             |  |
|-------------|--|
| Activity 1  | Project Description                                  |
| Activity 2  | Development of Alternatives                          |
| Activity 3  | Initial Screening of Alternatives                    |
| Activity 4  | Recommend and Conduct Additional Engineering Studies |
| Activity 5  | Technically Access and Evaluate the Alternatives     |
| Activity 6  | Prepare Preliminary Report                           |
| Activity 7  | Prepare Conceptual Design                            |
| Activity 8  | Prepare Final Report                                 |
| Activity 9  | Project Management Activities                        |
| Activity 10 | Community Relations Support                          |

#### Activity 1 -- Project Description

This task should include describing the current situation at the Cherokee County Site, the nature and extent of the contamination, and previous response or investigation activities. Information developed for Activity 1 of the remedial investigation should be used as appropriate. The material should be prepared to act as the introductory section of the Feasibility Study Report.

This introduction section will also include a site-specific statement of the purpose of the feasibility study, based on the results of the remedial investigation.

#### Activity 2 -- Development of Alternatives

Based on the work completed in the remedial investigations, a list of potential remedial actions will be developed. The development of potential alternatives will be based on site objectives and existing remedial technologies, and consider public health and environmental concerns.

Site-specific objectives will be established for the response. These objectives will be based on public health and environmental concerns, information gathered during the remedial investigation, Section 300.68 of the National Contingency Plan (NCP), EPA interim guidance, and the requirements of any other applicable Federal statutes. Preliminary cleanup objectives will be developed in consultation with EPA and the State.

Alternatives will be developed to incorporate remedial technologies, response objectives, and other appropriate considerations into a comprehensive, site-specific approach. The no-action alternative will be included in the evaluation of alternatives and may be a viable alternative (1) if the other remedial actions present a greater danger than the hazard itself, (2) if an appropriate engineering solution is not available technically, (3) if the site is determined not to be a threat to the public or the environment, or (4) if the cost of the remedy outweighs the benefits achieved.

### Activity 3 -- Initial Screening of Alternatives

The alternatives developed in Activity 2 will be screened by the Project Staff, EPA, and the State to eliminate alternatives that are clearly not feasible or appropriate, prior to undertaking detailed evaluations of the remaining alternatives.

Screening criteria will be developed to assess the remedial action alternatives. The factors addressed in developing the screening criteria will included:

- ° Economic - The capital and long-term operational and maintenance (O&M) costs are estimated and a present-worth value determined for cost comparison of alternatives.
- ° Environmental Effects - The adverse impacts of the alternatives, the adequacy of source control, and the acceptable mitigation of danger to public health and welfare and the environment will be identified. Included in the criteria will be permit requirements, institutional issues (e.g., implementability).
- ° Engineering - The alternative must be technically feasible regarding site location and conditions. It must be applicable to the project needs, and must be a reliable method of solving the problem.

The remedial action alternatives developed during Activity 2 will be screened according to the criteria described above, and a technical memorandum prepared summarizing the screening process. Project staff, EPA and representatives from appropriate Federal, State and/or local agencies will participate in this screening process to eliminate inappropriate and infeasible alternatives. The screening process will result in a refined final list of remedial alternatives.

### Activity 4 -- Recommend and Conduct Additional Engineering Studies

All remedial alternatives remaining after the screening process will be thoroughly evaluated. This evaluation will include review of the remedial investigation studies for all appropriate data. If necessary, the project team should also recommend and conduct further data collection, laboratory studies, or bench tests that would be necessary to fully evaluate the alternatives. Further studies might be required to evaluate the effectiveness or reliability of certain alternatives, or adequately compare the cost, constructability, applicability, and reliability of the alternatives. A separate work plan will be submitted for EPA approval for any proposed laboratory studies.

### Activity 5 -- Technically Assess and Evaluate the Alternatives

Based on the data from the remedial investigations and the information gained during Activities 1 through 4 of this Feasibility Study, all of the remedial action alternatives identified from the screening process should be refined and more fully developed.

a. Detailed Development of Remaining Alternatives

A detailed written description of each remaining alternative will be prepared including:

1. Description of appropriate treatment and disposal technologies.
2. Special engineering considerations required to implement the alternative (e.g., pilot treatment facility, additional studies needed to proceed with final remedial design).
3. Environmental impacts and proposed methods, and costs, for mitigating any adverse effects.
4. Operation, maintenance, and monitoring requirements of the remedy.
5. Off-site disposal needs and transportation plans.
6. Temporary storage requirements.
7. Safety requirements for remedial implementation (including both on-site and off-site health and safety considerations).
8. A description of how the alternative could be phased into individual operable units. The description should include a discussion of how various operable units of the total remedy could be implemented individually or in groups, resulting in a significant improvement to the environment or savings in costs.
9. A description of how the alternative could be segmented into areas to allow implementation of differing phases of the alternative.
10. A review of any off-site facilities provided by the State to ensure compliance with applicable RCRA requirements, both current and proposed.

b. Environmental Assessment

An Environmental Assessment (EA) for each alternative will be performed. The EA will include, at a minimum, an evaluation of each alternative's environmental effects, an analysis of measures to mitigate adverse effects, physical or legal constraints, and compliance with CERCLA or other regulatory requirements.

Each alternative will be assessed in terms of the extent to which it will mitigate damage to, or protect, public health, welfare, and the environment, in comparison to the other remedial alternatives. The specific considerations to be used in the assessment will be different for source control alternatives and for off-site alternatives, as explained in EPA guidance. Consideration may be given to standards and criteria developed under Federal or State environmental and health statutes.

c. Cost Analysis

The cost of each feasible remedial action alternative (and for each phase or segment of the alternative) will be evaluated. The cost will be presented as a present worth cost and will include the total cost of implementing the alternative and the annual operating and maintenance costs. Both monetary costs and associated non-monetary costs will be included. A distribution of costs over time will be provided.

d. Evaluation and Recommendation of Cost-Effective Alternative

Alternatives will be evaluated using technical, environmental, and economic criteria. At a minimum, the following areas will be used to evaluate alternatives:

1. Reliability - Alternatives that minimize or eliminate the potential for release of wastes into the environment will be considered more reliable than other alternatives. For example, recycling of wastes and off-site incineration would be considered more reliable than land disposal. Institutional concerns such as management requirements can also be considered as reliability factors.
2. Implementability - The requirements of implementing the alternatives will be considered, including phasing alternatives into operable units and segmenting alternatives into project areas on the site. The requirements for permits, zoning restrictions, right of ways and public acceptance are also examples of factors to be considered.
3. Operation and Maintenance Requirements - Preference will be given to projects with lower operation and maintenance requirements, other factors being equal.
4. Environmental Effects - Alternatives posing the least impact (or greatest improvement) on the environment will be favored.
5. Safety Requirements - On-site and off-site safety requirements during implementation of the alternatives should be considered. Alternatives with lower safety impact and cost will be favored.
6. Cost - The remedial alternatives with the lowest total present worth cost will be favored. Total present worth cost will include capital cost of implementing the alternatives and cost of operations and maintenance of the proposed alternative.

The alternative determined to be the most cost-effective will be recommended. The recommendation will be justified by stating the relative advantages over other alternatives considered. Evaluation considerations will be applied uniformly to each alternative. The lowest cost alternative that adequately protects (or mitigates damage to) public health, welfare, or the environment and is technologically feasible and reliable will be considered as the cost-effective alternative.

The technical assessments and detailed alternative descriptions will be compiled and the alternatives ranked. The alternatives will be ranked first within each assessment category and then overall rankings will be developed.

Rankings should be based on professional judgment and experience. Meetings will be held to solicit input from EPA, State, and local agencies, or the public. A report will be prepared summarizing the comparative rankings and describing the advantages and disadvantages of each alternative. The result of Activity 5 will be the recommendation of a cost-effective alternative.

#### Activity 6 -- Prepare Preliminary Report

A draft preliminary report should be prepared summarizing data developed during the evaluation of alternatives and documenting the alternative remedial actions assessment process. On the basis of the entire evaluation process, one alternative or a combination of alternatives may be recommended for consideration in the conceptual design. Six copies of the draft report should be submitted to the RSPD.

The EPA will review the draft preliminary report and approve the recommended alternative, or work with the project team to develop a compromise alternative. EPA approval of the preferred alternative is required prior to conceptual design activities.

#### Activity 7 -- Conceptual Design

The conceptual design activity will be the mechanism by which the selected remedial alternative(s) is defined. The scope of work will provide the data needed to prepare a design consistent with the objectives of the proposed remedial action(s). The work scope will also include data sufficient for preparing an order-of-magnitude level cost estimated for the remedial action(s).

The principal tasks during the conceptual design activity will be to develop a detailed work plan for the activity and prepare the conceptual design. EPA will be included in the review of work plans and work products during conceptual design activities. The project staff may also be required to revise portions of the community relations plan to reflect the results of the conceptual design.

The following conceptual design elements will be developed, as required, for the remedial action(s) selected:

- ° A conceptual plan view drawing of the overall site, showing general locations for project actions and facilities.
- ° Conceptual layouts (plan and cross sectional views where required) for the individual facilities, other items to be installed, or actions to be implemented.
- ° Conceptual design criteria and rationale.



- ° A description of types of equipment required, including approximate capacity, size, and materials of construction.
- ° Process flow sheets and a description of the process.
- ° A description of structural concepts for facilities.
- ° Utility requirements and rationale.
- ° An inventory of the required environmental permits and institutional requirements.
- ° Operation and maintenance requirements.
- ° Engineering approach and implementation schedule.

#### Activity 8 -- Prepare Final Report

A final report presenting the results of the Feasibility Study and the conceptual design of the selected remedial alternative will be prepared. The final report will also incorporate the review comments received from EPA on the draft report, and document the decision process used by EPA and the contractor for selection of the preferred alternative.

Prior to drafting the report, selected project team members should meet with EPA to discuss the results of the feasibility study, input comments on the conceptual design, and review the report outline. Six copies of the draft Feasibility Study Report will be submitted to the RSPD for review. After receipt of written comments and revision recommendations, the report should be finalized. Six copies of the final report will be submitted to the RSPD.

#### Activity 9 -- Project Management Activities

This activity occurs throughout the feasibility study. General tasks of this activity include establishing project records; attending review meetings with U.S. EPA and state agencies; preparing monthly reports; recommending and documenting changes in the scope of work, if appropriate; monitoring staffing, budgets, and contractor performance; and maintaining quality assurance programs. These activities are further defined in Activity 7 of the Remedial Investigations.

#### Activity 10 -- Community Relations Support

Through the development of the feasibility study, community relations support as described in Activity 8 of the Remedial Investigations, will be required.